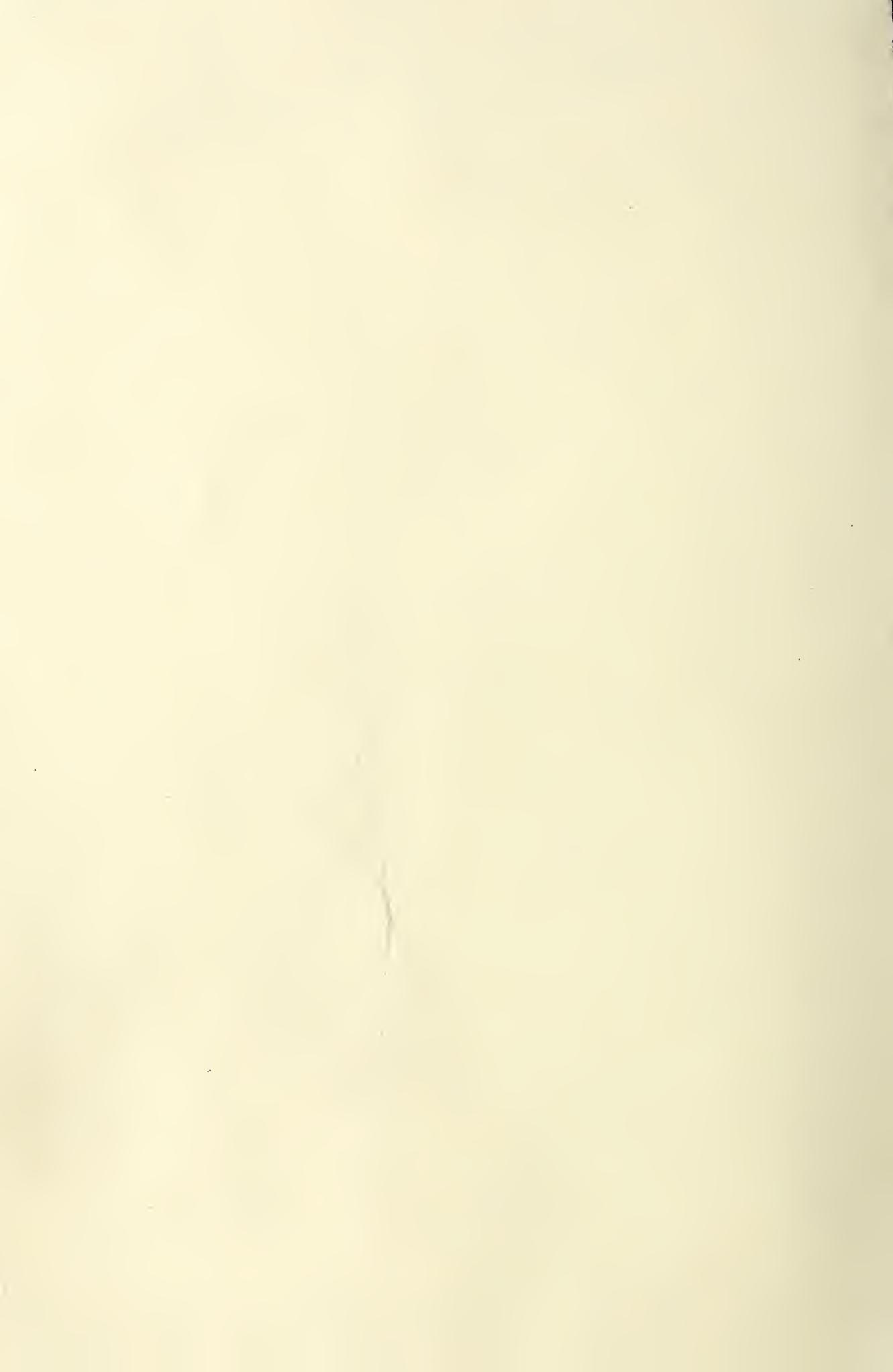


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TEXTBOOKS ON STATISTICAL PROCEDURES

applicable to
biological, chemical
and engineering research



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U.S. Agricultural Research Service. *2 minatell*
UNITED STATES DEPARTMENT OF AGRICULTURE

FOREWORD

The study of the general principles of experimental design is a relatively recent development. The application of these principles has proved invaluable to the more effective use of available experimental material and frequently has brought about considerable improvement in the precision of experimental comparisons.

To help stimulate the use of better statistical methods, information^{1/} has been compiled on numerous textbooks relating to statistical theory and experimental statistics. This article has been prepared primarily for the use of the research personnel of the Agricultural Research Service. It is hoped that this information will aid the investigator in the evaluation of such books for private or field-laboratory libraries.

Copies of the article can be obtained from Biometrical Services, Agricultural Research Service, Plant Industry Station, Beltsville, Md.

E. L. LeClerg
Chief, Biometrical Services
Agricultural Research Service

^{1/} The books listed and comments thereon do not imply that they are necessarily endorsed by the U. S. Department of Agriculture in favor of other books not mentioned.

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TEXTBOOKS ON STATISTICAL PROCEDURES
APPLICABLE TO BIOLOGICAL,
CHEMICAL, AND ENGINEERING RESEARCH

W. D. Hanson^{1/}

Although statistics, as a field of science, is relatively new, numerous books on various phases of statistical theory and procedures are now available. The purpose of this summary is to list pertinent textbooks covering statistical procedures applicable to biological, chemical, and engineering research and to present a brief abstract of each.

TEXTBOOK	COMMENTS
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INTRODUCTORY STATISTICS

Elementary Statistics

Freund, J. E. Modern Elementary Statistics. 418 pp., Prentice-Hall, N. Y., 1952.

These books are suggested for beginners for foundation information. These texts do not replace those on experimental statistics.

Fryer, H. C. Elements of Statistics. 262 pp., John Wiley & Sons, N. Y., 1954.

Mode, E. B. The Elements of Statistics. 377 pp., Prentice-Hall, N. Y., 2nd Ed., 1951.

Intermediate Statistics

Dixon, W. J., and F. J. Massey. Introduction to Statistical Analysis. 370 pp., McGraw-Hill, N. Y., 1951.

Concepts of statistics are presented to demonstrate general application of statistical techniques. The book requires minimum mathematics or a facility with elementary algebra and could serve as a background for work in experimental statistics.

²⁰
1/ Biometrician, Biometrical Services, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Md.
(see 2a)

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TEXTBOOK	COMMENTS
EXPERIMENTAL STATISTICS	
<u>Philosophy of Statistical Techniques</u>	
Finney, D. J. An Introduction to Statistical Science in Agriculture. 179 pp., John Wiley & Sons, N. Y., 1953.	As the author points out, this is not a textbook on the application of statistical procedure but rather an introduction to the application of statistics to agriculture with discussions of uses, limitations, and basic principles. Good sampling technique, objective analyses, logical basis of significance, and related topics are discussed.
Fisher, R. A. Statistical Methods for Research Workers. 356 pp., Oliver & Boyd, London, 12th, Ed. rev., 1954.	The author presents general principles and philosophies of statistical methodology illustrated by a diversity of examples. The breadth of the textbook makes it essential on most reference shelves.
<u>General Application of Statistical Techniques</u>	
Federer, W. T. Experimental Design Theory and Application. 544 pp., Macmillan, N. Y., 1955.	See Experimental Designs
Goulden, C. H. Methods of Statistical Analysis. 467 pp., John Wiley & Sons, N. Y., 2nd Ed., 1952.	The book gives the details of analyses demonstrating principles essential to the understanding of experimental designs. Additional topics, such as discriminant function, probit, and sequential analyses, are discussed briefly. A knowledge of elementary statistics would be helpful in understanding the material presented.
Ostle, B. Statistics in Research. 501 pp., Iowa State College Press, Ames, Iowa, 1954.	Represented in the textbook is a detailed discussion of methodology and statistical analyses together with examples. Many biologists may find the presentations difficult to follow without a background in basic mathematics.

TEXTBOOKS	COMMENTS
Snedecor, G. W. Statistical Methods. 534 pp., Iowa State College Press, Ames, Iowa, 5th Ed., 1956.	This book is a standard reference for methods of statistical analysis for most research workers. Statistical methodology and philosophy for the handling of experimental data are adequately covered in a manner easily understood by the research worker. A beginner may find an elementary textbook on statistics a helpful prerequisite for an understanding of material presented.
<u>pplication to Chemistry and Industrial Chemistry</u>	
Bennett, C. A., and N. L. Franklin Statistical Analysis in Chemistry and the Chemistry Industry. 724 pp., John Wiley & Sons, N. Y., 1954.	This book is a self-contained treatise and reference manual addressed primarily to the applied chemists and chemical engineers. Its purpose is to explain statistical ideas and methods and to illustrate applications in applied chemistry.
Brownlee, K. A. Industrial Experimentation. 194 pp., Chemical Publishing Co., N. Y., 4th Ed., 1952.	The book is an introduction to the use of statistical methods in the planning and interpreting pilot-plant and plant-scale industrial experiments. Emphasis is placed upon the application of tests of significance and inference. Some previous knowledge of statistics is desirable.
Davies, O. L. (Editor). Design and Analysis of Industrial Experiments. 637 pp., Hafner Pub. Co., N. Y., 1954.	This book deals with application of statistical methods to the design and analysis of chemical and industrial research, many of the examples being drawn from actual industrial research. The author presupposes a degree of facility in statistical methodology.
Tippett, L. H. C. Technological Applications of Statistics. 189 pp., John Wiley & Sons, N. Y., 1950.	Based on a lecture series, the book presents an informal discussion of statistical principles and methods from a standpoint of applications to manufacturing and scientific experimentation. The book is simply written with concrete examples drawn from industrial experimentation.

TEXTBOOK	COMMENTS
Youden, W. J. Statistical Methods for Chemists. 126 pp., John Wiley & Sons, N. Y., 1951	The textbook is confined primarily to the exposition of statistical techniques that will be useful to the chemists in planning experiments and interpreting data. Brevity is achieved by its limiting scope; however, the discussion of topics is adequate and is presented in such a manner that most chemists can understand them without previous statistical knowledge.
<u>Advanced Experimental Statistics</u>	
Anderson, R. L., and T. A. Bancroft Statistical Theory in Research. 399 pp., McGraw-Hill, N. Y., 1952.	The book has two objectives, to serve as an introduction to mathematical statistics and as a reference for research workers for the statistical theory and the analysis of experimental models by least squares techniques. The level of presentation assumes previous experience with statistical methods and calculus.
Kempthorne, O. The Design and Analysis of Experiments. 631 pp., John Wiley & Sons, N. Y., 1951	See Experimental Designs.
Rao, C. R. Advanced Statistical Methods in Biometric Research. 390 pp., John Wiley & Sons, N. Y., 1952.	The first part of the book covers matrix algebra, distribution theory, testing hypotheses, theory of estimation, and methods of maximum likelihood. The principle contribution of the author is a detailed development of multivariate analyses with applications to the field of biology. Considerable background in statistics, matrix algebra, and calculus would be considered as prerequisite for the reader.

TEXTBOOK

COMMENTS

EXPERIMENTAL DESIGNS

General Application

Cochran, W. G., and G. M. Cox
Experimental Designs. 454 pp.,
John Wiley & Sons, N. Y., 1950.

Sound statistical procedures are premised on data acquired from properly designed experiments. Statistical concepts and techniques are discussed. About 150 experimental plans or designs have been chosen to fit a variety of experimental conditions. The book is of interest to students of statistics and professional workers in all branches of science. It forms a basic reference for experimental designs. A general familiarity with statistics is presupposed.

Federer, W. T. Experimental Design Theory and Application. 544 pp., Macmillan, N. Y., 1955.

The level of the text presupposes a general familiarity with statistics and a reasonable facility with matrix algebra. Designs are discussed in a uniform pattern; that is, advantages, disadvantages, construction randomization, analysis, etc. A section of the book is devoted to additional problems.

Fisher, R. A. The Design of Experiments. 244 pp., Hafner Pub. Co., N. Y., 6th Ed., 1951.

The book is designed not to provide instructions for designing experiments, but rather to declare general principles and to illucidate them with a diversity of examples. The text represents the forerunner of present-day design texts.

Kempthorne, O. The Design and Analysis of Experiments. 631 pp., John Wiley & Sons, N. Y., 1952.

This textbook complements "Experimental Designs" by Cochran and Cox; it contains a fuller expression of the theory and a more detailed development of the basis for experimental designs. The textbook is a reference text for the design consultant and mathematical statistician. Unless an experimenter has an unusual mathematical background, the text would be of limited value to him.

TEXTBOOK	COMMENTS
Quenouille, M. H. The Design and Analysis of Experiment. 356 pp., Hafner Pub. Co., N. Y., 1953.	The book contains a comprehensive treatment of modern experimental design but, as a textbook, it lacks sufficient computational details, particularly with reference to the more complex designs. Considerable background in statistics would be necessary before one attempts to read the book.
MATHEMATICAL STATISTICS	
<u>Introductory</u>	
Hoel, P. G. Introduction to Mathematical Statistics. 331pp., John Wiley & Sons, N. Y., 2nd Ed., 1954.	The book provides an introduction to the theory and the applications of mathematical statistics. It is a basic textbook for students with an elementary background of calculus.
Kenney, J. F., and E. S. Keeping Mathematics of Statistics. Vol. I, 346 pp., 3rd Ed., 1954. Vol. II, 429 pp., 2nd Ed., 1951. V. D. Van Nostrand, N. Y.	Vol. I. The authors present the simple concepts of statistics together with practical applications. This presupposes a facility with algebra. Vol. II. The author presents the concepts basic to mathematical statistics. This presupposes a knowledge of calculus.
Mood, A. M. Introduction to the Theory of Statistics. 433 pp., McGraw-Hill, N. Y., 1950.	The books present an extensive coverage of the basic concepts of mathematical statistics. The level of the textbook presupposes a knowledge of applied statistics and calculus. A course in probability would be helpful.
<u>Advanced Topics</u>	
Cramer, H. Mathematical Methods of Statistics. 575 pp., Princeton Univ. Press, Princeton, N. J., 1946.	The book presents an exposition on the mathematical theory of modern statistical methods as based on the concepts of probability. Considerable mathematical background in calculus, probability theory, geometry, and real functions is required for the use of the book.

TEXTBOOK

COMMENTS

Kendall, M. G. Advanced Theory of Statistics. 1952. Vol. I, 457 pp., 5th Ed., 1952; Vol. II, 521 pp., 3rd Ed., Hafner Pub. Co., N. Y., 1951.

These textbooks are the standard references for mathematical statistics. They contain a comprehensive coverage of concepts and techniques used in advanced mathematical statistics. Background in calculus, matrix, algebra, and mathematical statistics would be required for the use of the books.

Wald, A. Statistical Decision Functions. 179 pp., John Wiley & Sons, N. Y., 1950.

The book is an important contribution to statistical theory concerning sequential testing or multi-stage testing. The book is written on a highly theoretical plane and would be of limited value to a research worker unless he were well grounded in theoretical statistics.

SPECIAL TOPICS

Quality Control

Burr, I. W. Engineering Statistics and Quality Control. 442 pp., McGraw-Hill, N. Y., 1953.

The application of statistical techniques to quality control of manufactured products is emphasized. Theory and applications are presented. The textbook may have most utility for advanced students in engineering and physics.

Grant, E. L. Statistical Quality Control. 563 pp., McGraw-Hill, N. Y., 1946.

This book represents a working manual for production and inspection supervisors, for engineers, and for management. Its contents could be assimilated by all technically trained personnel interested in quality control.

Biological Assay

Bliss, C. I. Statistics of Bioassay with Special Reference to the Vitamins. 187 pp., Academic Press, N. Y., 1952.

The textbook is designed primarily for workers in the field of vitamins research; however, techniques given should be of interest to those working in bioassay. The book is written for biologists. An adequate description of the steps involved in each analysis, together with the general philosophy underlying analyses, are given. The book is designed for beginners requiring only a general knowledge of algebra.

TEXTBOOK	COMMENTS
Finney, D. J. Statistical Method in Biological Assay. 661 pp., Hafner Pub. Co., N. Y., 1952.	Detailed developments of methods of bioassay are given, starting with a single dose response concept and progressing through advanced techniques. Probit analysis is also covered. Although the level of the textbook presupposes a knowledge of statistical procedures and design principles, non-mathematically trained investigators should not have great difficulty in understanding the procedures discussed.
<u>Sampling</u>	
Cochran, W. G. Sampling Techniques. 330 pp., John Wiley & Sons, N. Y., 1953.	The textbook presents the concepts and theory of sampling techniques required by the survey statistician. For an understanding of the proofs given, the level of the text presupposes a familiarity with algebra and calculus although the author discusses many topics which can be understood without a mathematical background.
Hansen, M. H., W. N. Hurwitz, and W. G. Madow. Sampling Survey Methods and Theory. Vol. I, 639 pp., Vol. II, 332 pp., John Wiley & Sons, N. Y., 1953.	Authoritative treatment of sampling survey methods used by the Bureau of Census and other organizations. Vol. I would serve as a reference or manual for the investigator concerned with the interpretations of the data. Vol. II is intended for the research work requiring formal command of sampling theory and designs.
<u>Miscellaneous</u>	
Pearce, S. C. Field Experimentation with Fruit Trees and Other Perennial Plants. 131 pp., Tech. Comm. 23, Comm. Bur. Hort. & Plant Crops, East Malling, Maidstone, Kent, England, 1953.	Experimental techniques related to fruit tree and other perennial plants are given. The book would serve as a guide to persons with a basic knowledge of statistics who are engaged in the field of long-term experimentation.

TEXTBOOK	COMMENTS
Yates, F. The Design and Analysis of Factorial Experiments. 95 pp., Tech. Comm. 35, Comm. Bur. of Soil Science, Harpenden, England, 1937.	Experimental techniques related to the design and analysis of factorial experiments are given. Detailed discussions of the handling of factorials in confounded designs are included. The communication presupposes a basic knowledge of statistics.
<u>Tables</u> Fisher, R. A., and F. Yates. Statistical Tables for Biological, Agricultural, and Medical Research. 126 pp., Hafner Pub. Co., N. Y., 4th Ed., 1953.	Contains tabular values for the t, X^2 , Z, and F distributions, the normal probability integral, probabilities, orthogonal polynomials random numbers, and other pertinent tabular information.

